

WE CLAIM:

1. A device for automated composite lay up using a material delivery head, comprising:

a mandrel having a vertical axis and an outside mold surface on the inside of said mandrel;

5 a vertical movement shaft disposed inside said mandrel;

an arm mechanism, supported by said vertical movement shaft, that moves and positions the material delivery head inside said mandrel, wherein composite material is delivered directly to said outside mold surface.

2. The device of claim 1, further comprising:

a platform supported by said vertical movement shaft wherein said platform moves vertically up and down inside said mandrel.

3. The device of claim 1, further comprising:

a plurality of arm mechanisms supported by said vertical movement shaft; and

5 a plurality of material delivery heads, wherein each of said plurality of material delivery heads is supported by at least one of said plurality of arm mechanisms.

4. The device of claim 1, wherein:

said arm mechanism supports the material delivery head;

said arm mechanism provides full circumferential positioning of the material delivery head inside of said mandrel at said outside mold surface.

5. The device of claim 1, further comprising:

a pressure vessel having heating channels and surrounding said mandrel.

6. The device of claim 3, wherein at least one of said plurality of material delivery heads is a flat tape laying machine.

7. The device of claim 3, wherein at least one of said plurality of material delivery heads is a contour tape laying machine.

8. The device of claim 3, wherein at least one of said plurality of material delivery heads is a fiber placement head.

9. A device for automated composite lay up of a part, comprising:
a mandrel having a vertical axis, wherein said mandrel has an interior mandrel surface that conforms to an outside mold line of the part;
a vertical movement shaft disposed inside said mandrel;

5 and an arm mechanism supported by said vertical movement shaft;

and
a material delivery head, supported by said arm mechanism,
wherein said arm mechanism moves and positions said material delivery head relative to said interior mandrel surface, wherein composite material is delivered
10 directly to said outside mold line on said interior mandrel surface.

10. The device of claim 9, wherein said mandrel includes two separable portions that facilitate removal of the part.

11. The device of claim 9, further comprising:
a platform that is supported and moved up and down by said vertical movement shaft wherein said arm mechanism is attached to said platform.

12. The device of claim 9, further comprising:

a platform that is supported by said vertical movement shaft, is moved up and down by said vertical movement shaft, and rotates about said vertical axis;

5 a plurality of arm mechanisms attached to said platform; and
 a plurality of material delivery heads, wherein each of said plurality of material delivery heads is moved and positioned relative to said interior mandrel surface by at least one of said plurality of arm mechanisms, wherein composite material is delivered by said plurality of material delivery heads
10 directly to said outside mold line on said interior mandrel surface.

13. The device of claim 9, wherein:

said arm mechanism provides full circumferential positioning of said material delivery head to said outside mold line on said interior mandrel surface.

14. The device of claim 9 wherein:

said arm mechanism provides motion of said material delivery head relative to said interior mandrel surface in a direction normal to said interior mandrel surface; and

5 said arm mechanism provides rotation of said material delivery head relative to said interior mandrel surface about an axis normal to said interior mandrel surface.

15. A device for automated composite lay up of a part, comprising:
 - a mandrel having a vertical axis, wherein said mandrel has an interior mandrel surface that conforms to an outside mold line of the part;
 - a vertical movement shaft disposed inside said mandrel;
 - 5 a platform that is supported and moved up and down on said vertical movement shaft;
 - an arm mechanism attached to said platform; and
 - a material delivery head, supported by said arm mechanism, wherein said arm mechanism moves and positions said material delivery head relative to said interior mandrel surface, wherein composite material is delivered directly to said outside mold line on said interior mandrel surface.
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16. The device of claim 15 wherein:
 - said arm mechanism provides motion of said material delivery head relative to said interior mandrel surface in a direction normal to said interior mandrel surface; and
 - 5 said arm mechanism provides rotation of said material delivery head relative to said interior mandrel surface about an axis normal to said interior mandrel surface;
 - said arm mechanism provides circumferential positioning of said material delivery head relative to said interior mandrel surface.
17. The device of claim 15, further comprising:
 - a plurality of material delivery heads, wherein said plurality of material delivery heads delivers composite material directly to said outside mold line on said interior mandrel surface.

18. The device of claim 15, wherein:
 - 5 said platform supports a creel for said material delivery head;
 - said platform supports a control module for said arm mechanism; and
 - 5 said platform is dimensioned to support a human operator.
19. The device of claim 15, wherein said mandrel includes at least two separable portions that facilitate removal of the part.
20. The device of claim 15, further comprising:
 - 5 a pressure vessel having heating channels and surrounding said mandrel; and
 - an autoclave door sealable to said pressure vessel.
21. An aircraft part manufacturing device for automated composite lay up, comprising:
 - 5 a mandrel having a vertical axis, wherein said mandrel has an interior mandrel surface that conforms to an outside mold line of the aircraft part;
 - 5 part;
 - 10 a vertical movement shaft disposed inside said mandrel;
 - a platform wherein:
 - 5 said platform is supported by said vertical movement shaft;
 - 5 said platform is moved up and down on said vertical movement shaft; and
 - 10 said platform rotates about said vertical axis;
 - an arm mechanism attached to said platform; and
 - 15 a material delivery head, supported by said arm mechanism, wherein:
 - 5 said arm mechanism provides motion of said material delivery head relative to said interior mandrel surface in a direction normal to

said interior mandrel surface; and

20 said arm mechanism provides rotation of said material delivery head relative to said interior mandrel surface about an axis normal to said interior mandrel surface;

said arm mechanism provides circumferential positioning of said material delivery head relative to said interior mandrel surface; and

composite material is delivered directly to said outside mold line on said interior mandrel surface.

22. The device of claim 21, further comprising:

a plurality of material delivery heads, wherein said plurality of material delivery heads delivers composite material directly to said outside mold line on said interior mandrel surface.

23. An aircraft part manufacturing device for automated composite lay up, comprising:

a mandrel having an axis of symmetry and an outside mold surface on the inside of said mandrel,

5 means for situating said mandrel so that said axis of symmetry is vertical;

means for supporting a material delivery head inside said mandrel; and

10 means for moving and positioning the material delivery head inside said mandrel so that composite material is delivered directly to said outside mold surface.

24. The device of claim 23, further comprising:

means for moving the material delivery head vertically up and down inside said mandrel.

25. The device of claim 23, further comprising:
means for circumferentially positioning the material delivery head about a vertical axis and around the inside of said mandrel.
26. The device of claim 23, further comprising:
means for moving and positioning a plurality of material delivery heads relative to said outside mold surface wherein composite material is delivered from said plurality of material delivery heads directly to said outside mold surface on the inside of said mandrel.
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27. The device of claim 23 wherein said means for supporting a material delivery head further comprises:
means for providing motion of said material delivery head relative to said outside mold surface in a direction normal to said outside mold surface;
5 and
means for providing rotation of said material delivery head relative to said outside mold surface about an axis normal to said outside mold surface.
28. A method for automated composite lay up of a part, comprising steps of:
situating a mandrel, having an axis and an outside mold surface on the inside of said mandrel, so that said axis is vertical;
5 placing said mandrel so that a vertical movement shaft is disposed inside said mandrel;
supporting an arm mechanism by said vertical movement shaft wherein said arm mechanism moves and positions a material delivery head inside said mandrel; and
10 delivering composite material directly to said outside mold surface.

29. The method of claim 28, further comprising steps of:
 - attaching said arm mechanism to a platform;
 - supporting said platform by said vertical movement shaft;
 - moving said platform up and down using said vertical movement shaft.
30. The method of claim 28, further comprising a step of:
 - rotating said platform and said arm mechanism around a vertical axis.
31. The method of claim 28, further comprising steps of:
 - moving and positioning a plurality of material delivery heads relative to said outside mold surface;
 - delivering composite material from said plurality of material delivery heads directly to said outside mold surface on the inside of said mandrel.
32. The method of claim 28 wherein said supporting step further comprises:
 - providing motion of said material delivery head relative to said outside mold surface in a direction normal to said outside mold surface; and
 - providing rotation of said material delivery head relative to said outside mold surface about an axis normal to said outside mold surface.
33. The method of claim 28, further comprising steps of:
 - separating a plurality of separable portions of said mandrel; and
 - removing the part.